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Articles PAGE

An Astronomical Trip to Australia—On the Way - *C. A. Chant* 249

Audibility of the Aurora - - - - - - *J. G. Griffin* 255

Old Observations Bearing on the Duration of Sunrise and Sunset - - - - - *Willard J. Fisher* 261

Observations of Falling Meteorites - - - *George P. Merrill and Arthur Taber Jones* 263

Meetings of the Society - - - - - - 267

Notes from the Meteorological Service - - - - 269

Book Reviews - - - - - - - - 272

Notes and Queries - - - - - - - 274

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THE JOURNAL
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VOL. XVI SEPTEMBER-OCTOBER, 1922 No. 124

AN ASTRONOMICAL TRIP TO AUSTRALIA—ON THE WAY

BY C. A. CHANT

AFTER extensive preparations to observe the eclipse of the sun which takes place on September 21st next and the path of which crosses the Australian continent, the present writer, accompanied by his wife and daughter, left Toronto on the evening of June 7th by Canadian National express, bound for Vancouver. At the time of departure Mars was seen, "bright as a marigold", in the south-east, and Jupiter and Saturn a little past the meridian. On waking some hours later and looking out of the sleeping-car window the two last-named planets were well down to the western horizon. Next morning the first "station" seen was McVittie, though there was no station building observable. We were 240 miles from Toronto. About noon a sign (without a building) was reached, bearing the well-known name of Stupart, the Director of our Meteorological Service.

Next morning (Friday, June 9th) Port Arthur and Fort William were reached, with their enormous elevators and fine steamships, and the route then continued along beautiful rivers and beside picturesque lakes. At 2.45 we reached Fort Frances and not long after, Rainy River. Here we crossed a fine iron bridge and came to Baudette in Minnesota. Then the train speeded along the south shore of the Lake of the Woods and soon arrived at Sprague, Manitoba. At 10 p.m. the great city of Winnipeg was reached. After a short rest we started forward again and in the morning

found ourselves in the province of Saskatchewan. Over its broad and fertile plains we travelled all day, a brief halt being made at Saskatoon at 1 p.m.

At 11.20 p.m. we reached Edmonton, Alberta, and at this fine city a two-day break in the journey was made. During this time at a meeting of the Canadian Club the writer had the privilege of outlining to the Chief Justice of Alberta, the Premier and a number of other very indulgent friends some significant features of the Einstein Theory and of explaining how astronomers were endeavouring to obtain experimental evidence either for or against it. Leaving Edmonton on Monday night, next morning Jasper Park was reached and Mt. Robson, the highest peak in the Canadian Rocky Mountains, and Mt. Edith Cavell were greatly admired. We passed through beautiful scenery all day (and all night too) and next morning came to Vancouver. On calling at the office of the Canadian-Australasian Line I found the officers there anxious to make our expedition a pleasant and successful one, and was assured that our apparatus would be stored where it would not be injured by the tropical heat. A drive through the city revealed its great commercial importance and also the large number of charming homes which it possesses. At that time they were surrounded with a profusion of brilliant colour—roses and broom and flowering thorn predominating. Of course a visit was also made to the majestic Stanley Park. Our stay in Vancouver was made the more enjoyable by meeting several old and esteemed friends.

On Thursday morning at 10 o'clock we left by the steamer Princess Charlotte and after a pleasant sail over smooth water and under a blue sky we reached Victoria at 3.30 p.m. Here Messrs. W. E. Harper and R. K. Young, of the Dominion Astrophysical Observatory, with Mrs. Harper, met us, and we soon found ourselves in a hospitable home.

On Friday at noon there was a luncheon given by the Victoria Centre of the R.A.S.C., at which were present many of the writer's old-time friends, as well as several whose names were familiar to him but whom he had not met before. He was glad to meet again Mr. Trant who formerly lived at Regina where he was an active amateur astronomer. Impaired eyesight now prevents him from

making practical observations. An outline of the preparations made for the expedition and of the work which it aimed to do was given. Then in company with Director and Mrs. Plaskett there was a drive about the city, which certainly has many picturesque and pleasing features. A visit was also made to the famous "sunken garden" and other grounds of Mr. and Mrs. Butchart. One would have to travel many, many miles to find anything so artistic and beautiful,—indeed I have never seen gardens so wonderful, and moreover freely open to visitors. The drive ended on Observatory Hill, and the great 72-inch telescope was inspected with almost paternal interest. The sky was not very clear but Jupiter and Saturn and a faint star were observed through the instrument. An attempt is made to employ the telescope during every minute of every clear night, and work on several large problems is being vigorously pushed forward.

Next day, Saturday, June 17th, being joined by Dr. Young, we boarded the steamer *Makura*, 8,075 tons, and started for the southern hemisphere. This steamer and the *Niagara* constitute the Canadian-Australasian Line, which makes monthly trips each way between Vancouver and Sydney, calling at Honolulu in Hawaii, Suva in Fiji and Auckland in New Zealand on the way.

It was a beautiful afternoon as we steamed through the Gulf of Georgia, having on our left the imposing Olympic mountains with the snow showing prominently upon their summits and between their rocky ribs, while on our right were the numerous small islands fringing the great Vancouver Island. The land faded from view as darkness was coming on, and in the evening a small party of friends gathered in the Music Room and sang some familiar songs from the "University of Toronto Song-Book", a copy of which was produced by a New Zealand passenger. Indeed as the voyage proceeded we found that we had a number of excellent musicians on board, and as a consequence the evenings passed very pleasantly.

On this Saturday evening a notice was posted stating that at midnight the ship's clocks would be retarded 36 minutes. This was the difference between the Standard Time at Victoria and the local apparent, or true solar, time which the ship was expected to have next day at noon. We turned our watches back this amount.

This is the regular practice on board ship. The clocks are changed at midnight by an amount which will make them show correct time at noon on the following day, unless it is expected to make port during the day, in which case the clocks are changed so as to make their time agree with that of the port upon arrival there. This daily changing of the time was one of the interesting astronomical features of the voyage.

By June 22nd we had reached latitude 28° and the weather was warm and agreeable. The stewards removed the heavy bed-covers, the passengers discarded their overcoats and the deck-hands put up the awnings to protect us from the sun which at noon was within 5° from the zenith. On the date mentioned the officers, stewards and most of the passengers appeared dressed in cool white summer clothing.

On Saturday, June 24th, at 5 a.m., an early riser who was on the upper deck called out "land ahoy!" and when we got up shortly afterwards we saw Oahu, one of the Hawaiian islands, not far away on our starboard. After being examined by the U.S. Customs and Immigraton officials we were allowed to go ashore at 9 a.m. Taking an automobile we were driven through the Americanized city of Honolulu and along winding paved country roads with tropical vegetation on each side. The picturesque palm, banyan, mango, ponciana and other strange trees, many of them covered with brilliant flowers; also the rugged sides of mountains overlooking plains covered with fields of pine-apples; all called forth exclamations of wonder and admiration. At noon the sun was almost exactly overhead and the heat was intense. On returning to the ship the passengers were besieged by natives with garlands to sell. These they were expected to buy and on leaving to cast overboard, signifying that they would return again. The surf-riding, the aquarium with its gay-coloured and odd-shaped fishes, and the natives diving for coins thrown into the water from the ship's side were special attractions and engaged our attention until 2 p.m. when the third whistle blew and the ship once more headed southwards.

The night skies in general were cloudy, but on this evening the stars shone out with remarkable clearness, and there, about 10° above the southern horizon was the famous Southern Cross. I have been told that some people are disappointed on seeing this

constellation for the first time, but we were not. It stood upright and clearly suggested a cross. The two brightest stars of the Centaur, Alpha and Beta, point to the Cross somewhat as the "Pointers" of our "Big Dipper" indicate the position of Polaris. In the sky was also a grand display of the planets—Mars, Venus, Jupiter and Saturn—while the entire length of the Scorpion could be traced out with great ease. Jupiter at this time was almost in the zenith in the early evening and Mars came to this position some days later as we steamed southward. They were both very brilliant objects. On June 30th the eastern sky was clear in the evening and the Northern Cross (Cygnus) was seen coming up in an inverted position.

At 2.45 p.m., June 28th, we crossed the equator, but Father Neptune did not make his appearance and nothing special happened. Indeed the awnings of the ship and the trade-winds made life very pleasant, and deck-games were in progress continually. Another interesting series of observations was on Polaris. As everyone knows, its elevation above the northern horizon measures the number of degrees one is north of the equator. We saw it gradually get lower and lower until it became entirely invisible.

On Friday, June 30th, we went to bed as usual, but on rising next morning we found it to be Sunday, July 2nd. In other words, we had been deprived of Dominion Day this year! I need not explain that on reaching the 180th meridian from Greenwich going westward a day is dropped, while if going eastward a day is repeated. In this case on our ship Saturday was omitted, but at 10.30 a.m. we met the *Niagara*, northbound, about five miles away on our starboard, and on that ship the date was Saturday, July 1st, that day being repeated.

Next morning, July 3rd, we were among the Fiji Islands, and saw the surf beating on the coral reef fringing the shore. Finding the opening in the reef, the ship entered and soon drew up to the wharf. It was fairly covered with barefooted, scantily-clothed, woolly-headed, brown-skinned natives, who did the loading and unloading. A trip around the island by motor, lunch at the Grand Pacific Hotel with its native dishes, a visit to the shops and an inspection of the cement pier used by Dr. Klotz and Mr. Werry twenty years ago in determining transpacific longitudes filled in a six-hour stay.

The days were now getting decidedly shorter, and the appearance of the sun in the north, and of some of the ecliptic constellations overhead appeared strange to the astronomers. Thursday, July 6th, was extremely rough, a violent gale (declared by some of the officers to be 100 miles an hour) from the south-east shaking the great ship and doing some damage to it. The result was we arrived in Auckland, New Zealand, eight hours late. Here the journey was interrupted, in order to pay a short visit to the Dominion. At Rotorua, 171 miles south from Auckland, are wonderful thermal springs and curative baths. Formerly there were great geysers also, but they play rarely now. But from numerous openings in the earth steam and sulphurous fumes are continually emitted while in other openings water is boiling vigorously and occasionally shooting upward fully twenty feet. The natives (Maoris) do all their cooking at some of these hot pools. One feels that there is great energy not far below the surface of the earth. On June 10th, 1886, a mountain about ten miles distant exploded and covered many square miles of the country with volcanic dust and stones to a depth of one foot or more, destroying all the vegetation and taking the lives of 153 people. Some fifty miles farther south geysers are continually in action and destructive earthquakes are not rare.

On the *Makura*, by request of Captain Crawford and the Entertainment Committee, the present writer spoke to the passengers on the evening of July 4th and gave an outline of our expedition and what we hoped to accomplish. On reaching Auckland he was asked to address the Rotary Club on the 17th, and on this occasion also our plans were explained. New Zealand is a picturesque, mountainous country and the people seem more English than are Canadians. Auckland is surrounded by extinct volcanoes, now covered by vigorous vegetation. These, together with a large natural harbour, add much to the beauty of the situation.

On July 20th our party proceeds to Sydney by steamer *Manuka*. The distance is about 1,300 miles and it requires four days to make it. Then we proceed onward to Melbourne, Adelaide and Perth, from which place we sail up the west coast.

Auckland, New Zealand.
July 18th, 1922.

AUDIBILITY OF THE AURORA*

By J. G. Griffin

MY attention has recently been engaged upon a matter that may be looked upon as, at any rate, partly, of astronomical interest, resulting in my writing the following pages, which perhaps may be thought worthy of the consideration of our members (*i.e.*, the N.S.W. Branch of the B.A.A.).

I refer to what is called the *Audibility of the Aurora*. I cannot speak from any personal experience, but through the kindness of several Australian savants, and from some, chiefly Canadian, publications, I am able to bring certain evidence for and against the existence of the phenomenon, not forgetting that it is still a moot point with many observers.

I would particularly call attention to the very pronounced statement which Captain Amundsen made to Professor Sir Edgeworth David, and to the extremely interesting account Professor Cooke, the N.S.W. Government Astronomer, gives of his own experience of, possibly, an analogous character, and which, as far as I know, has never previously been recorded.

In *Science* for September, 1921, Dr. H. D. Curtis, Director of the Allegheny Observatory, who is well known as a highly competent and skilful observer, when writing on this subject, states:

"I desire to place on record certain early experiences under almost perfect conditions of isolation and quiet. While in charge of the Labrador Station of the Lick Observatory—Crocker Eclipse Expeditions of 1905—much of the work of adjusting the instruments was necessarily done at night. The Station was located at Cartright (latitude 53° 42′ N.), and auroral displays were frequent and bright during July and August. On several nights I heard

*Mr. J. G. Griffin, the author of this paper, who lives at Carlton, near Sydney, N.S.W., Australia, from the perusal of this Journal for November, 1921, was impressed by some remarks on the audibility of the aurora, and made enquiries in Australia on the subject, with the results contained in this paper, which was presented and read to the N.S.W. Branch of the British Astronomical Society.

faint swishing, crackling sounds, which I could attribute only to the Aurora. There were times when large, faintly luminous patches or "Curtains" passed rapidly over our camp; these *seemed* to be close, and not more than a few hundred feet above the ground, though doubtless much higher. The faint hissing and crackling sounds were more in evidence as such luminous patches swept over us."

Mr. H. E. S. Asbury, President of the Montreal Centre of the Royal Astronomical Society of Canada (to the Journal of which Society I am indebted for the previous as well as the next quotation) states that he heard the Aurora crackle about 11 o'clock at a place called Wood's Harbour (about 43° 30′ N.) when a wonderful auroral display occurred, and on two remarkable other displays, one at Durham, Grey Co. (about 44° 20′ N.), in 1884, and another at Brampton, Peel Co. (about 43° 40′ N.), in 1893, both in Ontario, Canada, when the rays seemed to merge into one another and shift about, "I distinctly heard sounds which I would liken more to the click made by a comb drawn through the hair, than a swish. This sound I heard on both occasions."

According to Mr. Hudson Stuck, F.R.G.S., in "Ten Thousand Miles by Dog Sled," many residents and travellers in Alaska, men whose word and statements are worthy of belief, claim that they have heard the Aurora swish across the sky."

In the communication I have received from Mr. H. A. Hunt, the Australian Commonwealth Meteorologist, he states that Mr. John Oxaal had heard such a sound, and that the latter observer mentions that Mr. Tryggve Gran, the only Norwegian Member of Scott's Expedition, once heard a peculiar noise attending the Aurora Australis. A Mrs. Craig gives an instance of these sounds being heard at Dawson in the Yukon, and Mr. R. Flaherty also frequently heard them at St. John, N.B., and Halifax, N.S., Canada.

When I observed Dr. Curtis' statement, I ventured to enquire of Professor Sir Edgeworth David, if he had ever heard anything of the kind when he made one of the British Antarctic Expedition in 1907-9, led by the late Sir E. Shackleton. In his reply, dated 6th January last, he does not mention any personal experience, but makes the following interesting statement, viz.:

"Amundsen told me that when he was at Framheim, at the east end of the Barrier Reef, just before his famous dash to the South Pole, he was called out of his winter quarters one very cold night by Johannsen, in order to hear what Johannsen described as the crackling of the Aurora Australis. It was a very cold and very still night. Amundsen distinctly heard a very faint rhythmically repeated rustling noise in the air. After a time he discovered that this was due to the rapid freezing of the moisture from his breath, and the tiny tinkle made by the minute crystals as they slowly descended under gravity close to his face, sufficiently close for the ear just to catch the faint sound. He said there was no doubt about it that the rustling noises exactly coincided with the periods when he exhaled air from his lungs. He said that he was now confident that this was the true explanation of what the poets call the 'Crackling of the Northern Lights'."

It will be noticed that, accepting Amundsen's conclusion of their origin as correct, the sounds he heard must have been quite independent of the auroral display present at that time; and, while recognizing the great value of his opinion, one is tempted to enquire if there are any records of such sounds having been noticed by other people when no Aurorae were present. There must surely be some, if only occasionally, still nights, or even silent, cloudy, windless days, when a few of the many who have explored high latitudes would recognize and note such sounds, had they heard them when *Aurorae were absent*, and if so, one would be glad to find the records of such phenomena.

Again, it is quite clear that Dr. Curtis and other observers heard crackling and crinkling sounds in such low latitudes as from say 45° to 55° N. in summer time, when the temperature was too high to permit the breath to suddenly freeze and jingle in the way Amundsen describes. This, at any rate, is the opinion of Professor Cooke and of Mr. H. A. Hunt, for the former in his reply to my enquiries says "It seems to me impossible that such a sudden freezing of the breath could occur under the circumstances (*i.e.*, in latitude 53° 42′ N.); in fact, I should doubt it even during an Arctic night,"—and Mr. Hunt remarks "I think it highly improbable that the instant freezing of the moisture in a person's breath would ever occur about latitude 54° N. in the months of July and August."

Mr. Hunt went also to the trouble of having sent to me an extract from the "Reseau Mondial" giving data from 50 representative stations between latitudes 50° and 60° N. of the minimum temperatures below freezing point in July and August from the year 1910-13 inclusive, which Table I append.

Absolute Minimum Temperatures below 32° F. in July and August, 1910-13, between Lat. 50°-60° N.

				Fahr.	
Belle Isle.....	51° 53′ N.,	55° 23′ W.,	alt. 133 metres	28.0°	July 6-7, 1913
				23.0°	July 9,1912
Blagoveshchensk, Prusk.	58° 10′ N.,	114° 17′ E.,	alt. 490 "	30.4°	July 6,1913
				26.1°	Aug. 28,1913
				30.4°	Aug. 31,1912
				29.3°	Aug. 28,1911
Tygan Ourkan...	54° 5′ N.,	124° 6′ E.,	alt. 359 "	31.6°	July 3,1913
				28.4°	Aug. 25,1913
				29.3°	July 15,1912
				28.4°	Aug. 19,1912
				31.1°	July 11,1911
Davis Inlet.....	55° 50′ N.,	60° 50′ W.		22.0°	Aug. 26,1913
Irkutsk.....	52° 20′ N.,	104° 19′ E.,	alt. 467 "	31.3°	Aug. 26,1913
				30.4°	Aug. 27,1911
Calgary.....	51° 2′ N.,	114° 2′ W.,	alt. 1033 "	30.0°	Aug. 30,1912
				30.0°	Aug. 24,1910
Barkerville.....	53° 2′ N.,	121° 35′ W.,	alt. 1274 "	24.1°	Aug. 25,1910
Fort Chipewyan.	58° N.,	111° 10′ W.,	alt. 218 "	28.9°	Aug. 30,1910
Minnedosa.....	50° 15′ N.,	99° 50′ W.,	alt. 515 "	30.0°	Aug. 31,1910
Berens River....	52° 18′ N.,	97° 23′ W.,	alt. 216 "	30.0°	Aug. 18,1910

Professor Cooke's interesting and curious experience is worthy of great consideration in this connection, He writes, under 18th January last, when replying to my auroral audibility enquiry, "I have occasionally noticed an analagous sound, but more intense during a thunderstorm. Curiously I have only once heard it anywhere else than at the Perth, W.A. Observatory, and that was in Sydney a few days ago. In Perth, however, I heard it *always* when the flash was just overhead, and I have never seen any record of its occurrence. It consisted of a very sharp click, *coincident with the lightning* (the italics are the Professor's); the thunder came afterwards. My ear is specially trained in judging small intervals

of time, and I am quite positive that the click accompanied the lightning, not the thunder. What occasioned it I do not know, but as an aurora is probably associated with an electrical outburst, and tinkling noises have been heard in connection with it, these and my clicks may probably have something in common. This does not, of course, explain the sounds, but it tends to make one believe that they may really be associated with the Aurora."

In a subsequent letter the Professor remarks "I have always regarded that 'click' as a very interesting phenomenon, have heard it nowhere else, with the single exception I mentioned, and have come across no reference to it. It was very sharp, quite unmistakeable, and, as far as the memory can be trusted for such events, invariably heard when I was sitting quietly in my office, and a flash occurred quite close."

In leaving the subject with you, I trust I may be pardoned for hoping that you will find it of interest, worthy even of investigation, for, unimportant as it may appear at first glance, research might, in this instance, as it has so frequently done in others, lead to results which ultimately become valuable.

Sydney, 30th March, 1922.

I have since heard from Professor C. Stormer, of Christiania, Norway, University, that he had never heard the sounds.

Since writing this paper I have also received the following letter, dated 7th March, from Dr. H. D. Curtis. Director of the Allegheny Observatory, in the University of Pittsburgh, U.S.A., which confirms his previously published statement which I had quoted.

ALLEGHENY OBSERVATORY
UNIVERSITY OF PITTSBURGH

Riverview Park,
Pittsburgh,
PENNSYLVANIA.
7th March, 1922.

Mr. J. G. Griffin,
91 Mill Street,
CARLTON,
near SYDNEY, N.S.W.

Dear Mr. Griffin,

I was greatly interested in your letter of 16th January, and regret that I have not more information to give on this somewhat debateable point. You probably have read the matter at the

bottom of p. 934, Vol. II of the Encyc. Brit., where it is mentioned that the voyageurs of the H. B. Co. state that such sounds are not uncommon. The factor of the H. B. post at Cartright told me that he had often heard such sounds accompanying auroral displays.

Professor David's explanation of these sounds is possible enough for temperatures far below zero. It doesn't fit at all with the conditions at Cartright. We had light frosts several nights in the summer, but I believe they were not on the nights of greatest auroral display; from recollection, without the records of the expedition available, I should say that the temperature on these nights was around 40 degrees F.

The proximity of Labrador to the north magnetic pole makes the aurora a frequent and wonderful phenomenon there; I have never elswehere seen such bright and magnificent displays. I tried in vain to assign the sounds heard to some reasonable source other than the aurora, but was forced to exclude them as possible sources; besides, what I heard didn't *sound* like anything from anything I could postulate.

The conditions of quiet and isolation were ideal; around midnight and no one stirring except myself within a distance of many miles; an occasional Eskimo dog howling near the post a quarter of a mile away; landlocked quiet harbour with no perceptible breeze; no waves. Any surf sounds from the open sea were four or five miles off. I doubt if distant surf, if audible at such distances, could have given the peculiar swishing sounds, and certainly not the faint crackling. In short, I feel certain that the sounds I heard were caused by the aurora and nothing else. There was, moreover, a certain synchronism between the maxima of these sounds and the sweeping of auroral curtains across the sky.

Yours very truly,

(Sgd.) HEBER D. CURTIS.

OLD OBSERVATIONS BEARING ON THE DURATION OF SUNRISE AND SUNSET

By Willard J. Fisher

In 1769 the French academician Le Gentil went on a journey to Mauritius, Pondichéry and Manila, to observe the transit of Venus and to study atmospheric refraction in the tropics. As an incident of the latter, while at Pondichéry he observed carefully the form of the rising sun, with attendant phenomena, and noted the instants of upper and lower contacts in several cases, with the help of the telescope of his quadrant and a clock. While he does not seem to have made any further use of the durations deducible from his observations, nevertheless, with the help of the *Nautical Almanac* of that year and a standard astronomical formula, one may compute the duration which have held on the assumption of constant refraction, and may compare this with the actual observations and with the accompanying descriptions of the sun's form. The table shows the results. Averaging, type A*, which is a mirage type, has an average excess of 2.4 per cent. as compared with computation; the one type B case has an excess of 5.1 per cent. These results agree with numerous observations by the writer, made at various stations on Pacific and Atlantic waters. It is as if the sun sets behind a receding horizon, rises beyond an approaching horizon.

Table

Date local 1769	Obs. s	Duration Comp. s	Dif. s	Per cent.	Type
I 7A	148.5	144.6	+3.9	+2.8	A
I 9A	147.4	144.4	+3.0	+2.1	A
I 10A	145.0	144.1	+0.9	+0.6	A
II 1A	145.4	139.7	+5.7	+4.1	A
VI 18A	148.4	141.2	+7.2	+5.1	B

*Dominion Astrophysical Observatory, Victoria, B.C., December 20, 1921.

In 1893 A. L. Colton made a long series of photographs of the setting sun, which were published with explanatory text, partly in *Himmel und Erde*, more fully in the *Publications of the Lick Observatory*, No. 5. Four successive exposures were made each evening, the moments of exposure were noted and accompany the reproductions. In general no conclusion can be drawn from them as to the duration of sunset, for it is not obvious where among the four the moment of lower contact belongs. In the group of July 13, however, lower contact with a very level horizon evidently occurred considerably *before* exposure No. 1, which is marked 7h 25m 30s. On No. 4, in the half tone at least, there is no trace of the sun; but it had obviously not yet vanished in No. 3, which is marked 7h 30m 15s. On this occasion, therefore, sunset endured more than 285s., am excess of more than 106s. over the value of 179s. computed, or more than 59 per cent. excess. If No. 4 be allowed, marked 7h 31m 45s, the excess was more than 196s, or more than 110 per cent.

The interval between No. 2, 7h 27m 05s, and No. 3, was 3m 10s, in itself more than computed 179s, and corresponding to a descent of 32.8′, more than the sun's diameter.

The hazy appearance of parts of these four figures is explained in the text as due to a defect in the negative, and not to clouds.

Cambridge, Mass.

OBSERVATIONS OF FALLING METEORITES

A LETTER by George P. Merrill of the U.S. National Museum, Washington, on the subject mentioned in the headline, has raised some interesting discussion upon some of the points connected with it. Dr. Merrill's letter which appeared in "Science" of June 23, 1922, was as follows:

The numerous recently reported occurrences of falling meteorites are so contradictory and so at variance with what reason would lead one to expect as to make one quite cynical concerning the value of human testimony.

Few natural phenomena, it may be stated by way of introduction, are more likely to unduly excite the imagination than those attendant upon a fall of meteorites. The suddenness, the unexpected nature of the occurrence, the light and noise, and perhaps above all the sensation of fear aroused when a solid body is suddenly projected from seemingly empty space, all have effect, and it is not surprising that accounts are widely variable—dependent upon the flexibility of the imagination, more perhaps than upon powers of observation. Few persons, however well trained, can look calmly and critically upon the phenomena. Fewer yet can, in the brief space of time, estimate the height of the body when first seen, or note such facts as may be of service in calculating its direction and rate of progress.

A peculiar feature of the case is the lack of ability on the part of an observer to locate the place of fall unless, indeed, he happens to actually see it strike the ground. This is due to several causes, and, in part at least, to the low angle at which the stones sometimes enter our atmosphere, which permits a continuation of flight for some distance, even miles, beyond the point at which they seemingly must strike the earth, and in part to the fact that one is unable to correctly estimate the distance, which may be much greater than supposed. No less an experienced student and collector than the late H. A. Ward once told the writer of his experience in such matters. He was sitting in front of a house occupying a somewhat elevated position with reference to the

rest of the town. Suddenly a meteorite appeared descending from the sky, and fell, he was sure, within a certain square on the lower level. He at once proceeded to the spot, only to find that he was mistaken but that it had fallen a "few blocks away". At this second point the same experience was repeated, and the stone finally located some twenty miles beyond the point where he was "certain" he had seen it strike.

An equally good illustration was offered in the flight of a meteorite over the city of Washington on Sunday, January 12th, 1919. This was first called to my attention by a man some eighty miles south of Washington, who saw it, as he assured me, strike the ground within one half a mile of where he was standing. Inasmuch as the meteorite had been observed passing over Washington in a northeasterly direction his statement was not accepted. Further reports of the fall in the immediate vicinity of the city and a few miles away were also received. Taking the direction along which the meteorite was travelling, I followed it up by correspondence for a distance of over 300 miles into northeast Pennsylvania where it became lost. The last reports received indicate that it was going in two directions at once (?) and it is very probable that it actually fell somewhere in that vicinity, nearly 400 miles from where first *seen* to fall.

Experiences similar to the above are common. In many other instances stones which were "seen to fall" have proved to be of strictly terrestrial origin. There comes a sudden flash and report, the observer goes quickly to the spot and there finding an object which had not previously attracted attention, assumes it to be a meteorite and in perfectly good faith writes some museum announcing his discovery and willingness to dispose of the same. There is probably not a museum of importance in the world that does not annually receive from one to many announcements of this kind. The receipt even of glacial boulders which were "warm when picked up" or "which set fire to the grass at the point where they fell" is not unusual.

This leads to the second point to which attention need be directed—that relating to the reported temperature of the fallen body, which is often to the effect that "it was too hot to touch," or has been the cause of fires. As in a great majority of cases it is

impossible to investigate the actual temperature after the first report has been made it may be well for the moment to consider the probabilities.

While the original source from which meteorites are derived is problematical it yet seems certain that they have been wandering for an indefinite period in space and at a temperature of "absolute zero". At the time of entering our atmosphere it is fair to assume they are cold throughout to a degree of which we can have no conception. During the few seconds in which they are passing through our atmosphere, they become intensely heated on the immediate surface, but these portions are immediately stripped off, and, as we have absolute proof, the heat never extends to a distance of more than two or three millimeters. Before striking the ground the speed of the body is so far checked that it ceases to glow and the thin film of molten material quickly congeals. Cooling of the surface, owing to the intense cold of the interior, must follow rapidly and it is questionable in the writer's mind if a large majority of the reports of the heated condition of the meteorite when found are not based upon expectation rather than fact. He even goes so far as to suggest that when it shall become realized by the public at large that the chances are in favour of a meteoric stone being cold rather than hot when found, it will be so reported.

The foregoing remarks by Dr. Merrill prompted Prof. Arthur Taber Jones of Smith College, Northampton, Mass., to examine theoretically, and in a general way, what temperature a meteorite might reasonably be expected to have just before it enters our atmosphere. He gives the results of his calculations in "Science" of August 11th, 1922, and says: "The meteorite has certainly been for some time exposed to radiation from the sun, and it may well be that its temperature is much higher than the absolute zero."

Assuming that the meteorite is a sphere with a black surface, and that it is also a perfect conductor of heat, "the temperature of this sphere is determined by the condition that the rate at which it loses heat by radiation equals the rate at which it receives heat from the sun."And he then proceeds to calculate the temperature of the meteorite according to its distance from the sun, with the

following results: "If black spheres which conduct heat perfectly were placed at the same distance from the sun as the several planets (the equation) shows that the temperatures of these spheres would be the following:

"At the distance of

Mercury	180° C.
Venus	58° C.
Earth	9° C.
Mars	− 45° C.
Jupiter	−149° C.
Saturn	−182° C.
Uranus	−209° C.
Neptune	−221° C.

"We see that in the neighbourhood of the earth such a sphere would have a temperature above that of melting ice."

Prof. Jones makes further calculations varying the shape of the meteorite from the sphere to the cylinder, with results that do not differ very widely from ordinary temperatures at the earth's surface, when the distance of the meteorite from the sun is the same as that of the earth, which is a conclusion that one might naturally expect rather than a temperature of "absolute zero".

MEETINGS OF THE SOCIETY

AT VICTORIA

A special meeting of the Society was held on the 16th June the function taking the form of a luncheon on the occasion of the visit to the city of Professor Chant, Mrs. Chant and Miss Chant *en route* to Australia to observe the solar eclipse in September next. The details of their itinerary have already been given in the May-June issue of the JOURNAL.

A numerous and representative gathering of the members assembled to meet Professor Chant and in response to an invitation to address the meeting he prefaced his remarks by observing that he felt thoroughly at home confronting such familiar friends as Dr. J. S. Plaskett, Mr. W. E. Harper, Dr. R. K. Young and Mr. H. H. Plaskett. He had followed their careers from the time of their leaving the University of Toronto and had watched the process of the inauguration of the great Observatory on the Pacific coast with especial interest. His address dealt with the Einstein Relativity theory in a general way, with more particular reference to the arrangements in hand of himself and the other expedition parties to test out the Einstein predicted displacement of the stars in the field at the time of the eclipse.

Members were glad to have the opportunity of making the acquaintance of Professor Chant and of wishing him *bon voyage* and favourable conditions for the successful prosecution of his work.

The Chant party, accompanied by Dr. R. K. Young—representing the Dominion Astrophysical Observatory—left on the S.S. *Makura* on the following day.

AUGUSTIN SYMONDS, *Act. Secretary.*

A very popular meeting of the Victoria branch of the Royal Astronomica Society was that held 30th June at the Observatory on Gonzales Hill. About one hundred of the members and their friends made the trip to the top of the heights, and, although the moon and planets were obscured most of the evening by the cirro-stratus clouds, there were brief periods when the sky cleared sufficiently for visitors to observe these interesting heavenly bodies through one or other of the telescopes which were on hand for this purpose.

Mr. Napier Denison, who is in charge of the Observatory, had an interesting programme arranged in lieu of examination of the skies, and even without visual study of Mars, Jupiter, Venus, Mercury or the moon there was much to be seen

of more intimate interest in and about the building. Of the various instruments most interest was shown in the seismographs, three in number, two being of the horizontal type, one vertical. The manner in which these devices indicate earthquakes was very thoroughly explained by Mr. Denison, who also conducted his visitors to the room where the orrery is kept, and pointed out the action of this apparatus in illustrating the relative motions of the bodies in the solar system by rotation and revolution of balls moved by wheels. This instrument takes its name from its inventor, the Earl of Orrery.

Before the members began their inspection of the instruments, however, Mr. Denison sent up a hydrogen inflated balloon to illustrate the uses of this in studying the upper currents of the air. The balloon moves upwards at the rate of five hundred feet a minute, and several of the spectators were able to see the buoyant messenger when it was several thousand feet up, its zig zag path indicating the movement of the air currents in the higher atmosphere. These balloons are two feet in diameter, and are frequently sent up by meteorologists when information about the movements of air currents is sought.

No less than six telescopes were available for those who wished to study the skies that evening, three being brought up by visitors, while the Observatory itself has three. The meeting was voted a great success, Mr. W. E. Harper, the president, and members of the Society expressing their thanks to Mr. Denison for the trouble he had taken to make the occasion interesting.

AUGUSTIN SYMONDS, *Act. Secretary.*

NOTES FROM THE METEOROLOGICAL SERVICE

Agincourt and Meanook Magnetic Results, 1921

The accompanying tables give a summary of the results obtained at Agincourt and Meanook magnetic observatories during the year 1921.

The values of *D*, *H* and *Z* for Agincourt and of *D* for Meanook are obtained from the hour readings of the photographic records. The value of *I* at Agincourt is deduced from the *H* and *Z* means. The *H* and *I* for Meanook are obtained from absolute observations, uncorrected for diurnal variation, made twice a month for *H* and weekly for *I*. The observations are made alternately in the morning and afternoon. The value of *Z* is deduced from the means of *H* and *I*. All observations are corrected to International Magnetic Standard.

RESULTS OF MAGNETIC OBSERVATIONS AT AGINCOURT FOR 1921.
LAT. 43° 47′ N.; LONG. 79° 16′ W.

Agincourt Declination West

Month 1921	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range From 24 hour readings	Mean Daily Range From means of extremes
	° ′	° ′		° ′		° ′	′	′
January	6 48.2	7 09.4	1	6 31.2	23	0 38.1	6.6	13.4
February	48.2	6 59.0	2	6 24.6	13	0 34.4	6.7	12.9
March	49.1	7 04.6	29	6 17.3	21	0 47.3	10.4	19.3
April	49.4	7 32.7	13	6 27.8	21	1 04.9	10.7	21.6
May*	50.2	8 41.1	14,15	4 21.1	12	4 20.0	12.6	48.2
June	49.7	7 11.0	6	6 13.6	9	0 57.4	12.3	18.6
July	50.1	7 08.7	23	6 23.8	15	0 44.9	15.0	21.2
August	51.0	7 09.6	15	6 31.5	7	0 38.1	14.6	20.1
September	51.8	8 11.0	2	6 22.5	28	1 48.5	12.4	21.6
October	52.5	8 05.2	8	6 10.2	8	1 55.0	9.4	20.1
November	53.2	7 20.5	17	5 56.5	16	1 24.0	7.5	15.4
December	57.6	7 19.4	28	6 20.0	22	0 59.4	6.3	18.3

AGINCOURT HORIZONTAL FORCE

Month 1921	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range From 24 hour readings	Mean Daily Range From means of extremes
	γ	γ		γ		γ	γ	γ
January	15854	15892	11	15802	1	90	26	44
February	57	894	2	793	5	101	25	45
March	52	903	15	704	22	199	36	63
April	51	931	18	455	13	476	36	82
May*	31	16378	14	212	15	1166	108	213
June	46	15950	8	779	9	171	33	64
July	43	911	15	774	16	137	39	67
August	37	905	30	734	3	171	44	72
September	26	868	8	312	2	556	41	78
October	22	892	11	386	8	506	34	74
November	25	896	16	706	6	190	23	53
December	25	868	29	696	11	172	20	58

*May Maximum and Minimum exceeded limits of photographic register. Values estimated.

AGINCOURT VERTICAL FORCE

Month 1921	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range From 24 hour readings	Mean Daily Range From means of extremes
	γ	γ		γ		γ	γ	γ
January	58106	58120	10	58080	1	40	5	11
February	104	128	5	58075	21	53	4	12
March	095	131	27	58006	22	125	10	24
April	087	123	22	57855	13	268	17	36
May*	083	583	15	57435	14	1148	57	168
June	073	140	8	58017	7	123	10	25
July	064	099	15	57991	14	108	12	29
August	047	081	4	57932	3	149	14	33
September	046	118	2	57680	2	438	15	41
October	031	248	11	57543	8	705	24	48
November	022	096	5	57946	6	150	14	27
December	020	069	22	57957	12	112	8	23

*May Maximum and Minimum exceeded limits of photographic register. Values estimated.

RESULTS OF MAGNETIC OBSERVATIONS AT MEANOOK FOR 1921.
LAT. 54° 37′ N.; LONG. 113° 21′ W.

MEANOOK DECLINATION EAST

Month 1921	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range From 24 hour readings	Mean Daily Range From means of extremes
	° ′	° ′		° ′		° ′	′	′
January	27 37.0	28 03.5	5	27 05.9	18	0 57.6	6.8	23.1
February	36.5	28 43.6	5	27 08.2	17	1 35.4	6.6	22.3
March	36.1	29 00.3	15	26 52.1	25	2 08.2	9.1	34.4
April*	34.9	29 51.7	29	25 54.8	29	3 56.9	13.7	48.3
May†	33.5	30 12.7	14	23 56.5	14	6 16.2	17.7	73.6
June	33.5	28 08.8	17	27 01.7	8	1 07.1	16.2	26.4
July	31.9	28 17.9	8	26 46.6	16	1 31.3	15.0	28.6
August	31.6	29 28.7	3	26 31.7	3	2 57.0	14.9	33.5
September	31.3	29 37.0	2	25 54.0	2	3 43.0	13.0	39.0
October	30.7	29 51.1	8	25 53.9	8	3 57.2	9.4	39.2
November	31.4	28 40.0	16	26 27.1	17	2 12.9	7.5	27.9
December	30.8	28 38.6	13	26 26.6	11	2 12.0	5.9	31.7

*April Maximum and Minimum exceeded limits of photographic register. Values estimated.

†May Maximum and Minimum exceeded limits of photographic register. Maximum estimated. Minimum obtained from eye reading of differential instrument.

MEAN MONTHLY VALUES OF I AT AGINCOURT AND MEANOOK AND MEAN MONTHLY VALUES OF H AND Z AT MEANOOK FOR 1921.

Month 1921	Ag *I*	Me *I*	Me *H*	Me *Z*
			γ	γ
January	74 44.3	77 53.0	12934	60246
February	44.2	53.2	920	198
March	44.3	53.4	916	197
April	44.2	53.9	901	169
May	45.2	54.2	896	172
June	44.3	53.9	908	202
July	44.3	53.6	910	186
August	44.4	53.3	902	123
September	45.0	54.3	903	213
October	44.9	54.4	896	189
November	44.6	54.3	910	245
December	44.6	53.2	908	142

BOOK REVIEWS

Mars, by William H. Pickering, of the Harvard Astronomical Station, Jamaica. 173 pages, 5½ x 8 in., 8 plates. Boston: Richard G. Badger, 1921. Price $2.50.

Prof. W. H. Pickering is one of our most distinguished students of Mars and his writings on this subject have been numerous and important. In this book he has collected seventeen of his papers on the planet prepared between 1890 and 1914. They are all written in a simple, straightforward, lucid style and certainly give the one who reads them an excellent statement of facts and theories.

As is well known, Professor Pickering firmly believes in the objective reality of the fine markings on the planet's surface, and holds somewhat "advanced" views regarding its development and habitability; but that does not prevent him from presenting the objections which have been made against what he favours. The investigations of various astronomers have been outlined with appreciation and fairness.

In chapter VII is given a translation of an article by Schiaparelli, the discoverer of the "canals", which states his latest views on the physical condition of the surface of the planet. Chapter XIII, entitled, "What we know about Mars", extends to 27 pages and certainly contains an admirable summary of our knowledge of the planet.

The book is artistically printed and well illustrated.

C. A. C.

Astronomische Miniaturen von Elis Strömgren. 87 pages, 5½ x 8½ in., 14 illustrations. Berlin: Julius Springer, 1922.

This little volume by Professor Strömgren, of Copenhagen, is translated from the Swedish. Its object is to arouse a wider interest in the wonderful discoveries and investigations which have recently been made in astronomy. The author's aim is to be "popular" but exact, thus forming a basis for further study. The subjects treated are: the position of man in the universe; comets, their paths, nature and origin; the sun; a calendar pro-

blem; fundamental notions of modern stellar astronomy; Michelson's method of measuring small angular distances in the sky; Scylla and Charybdis.

In the first chapter is told the story of the politician who, seeing the millions of worlds as revealed by a great telescope, remarked that it did not make much difference who was elected, Taft or Bryan.

The book is written in a lively and pleasing style and those who understand the language will read it with pleasure. C. A. C.

The Telescope, by Louis Bell, Ph.D., Consulting Engineer. 285 pages, 6 x 9 in., 189 illustrations. New York: McGraw-Hill Book Co., 1922. Price $3.00.

The scope of this work is clearly stated in the preface, from which the following is quoted:

> This book is written for the many observers, who use telescopes for study or pleasure and desire more information about their construction and properties. . . . It deals primarily with principles and their application to such instruments as are likely to come into the possession, or within reach, of students and others for whom the Heavens have a compelling call. . . .
>
> Certain branches of the subject are not here discussed for lack of space or because there is recent literature at hand to which reference can be made. Such topics are telescopes notable chiefly for their dimensions, and photographic apparatus on which special treatises are available. . . .
>
> The present volume contains neither pictures of nebulae nor speculations as to the habitability of the planets; it merely attempts to bring the facts regarding the astronomer's chief instrument of research somewhere within grasp and up to the present time.

The titles of the chapters are: the Evolution of the Telescope; The Modern Telescope; Optical Glass and its Working; The Properties of Objectives and Mirrors; Mountings; Eye-pieces; Hand Telescopes and Binoculars; Accessories; The Testing and Care of Telescopes; Setting Up and Housing the Telescope; Seeing and Magnification.

The work has required much reading and sifting out of information by the writer, who is well-known as the author of other works dealing with light and electricity. The different chapters concisely summarise our knowledge of their various subjects, and are written in an interesting style. The book will be found of great value to astronomers and physicists, and will surely have a wide sale. C. A. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries

S. J. McKnight of 145 Shuter St., Toronto, writes that he saw in the city on the night of August 1st, about 9.25 p.m., E.S.T., a very beautiful "shooting star", low in the southern sky. Its course was almost, but not quite, horizontal, travelling due west, just beneath the moon at first quarter. There were thin clouds at the time, and it seemed to emerge from a cloud. It was much larger than a moving point of light,—very brilliant and beautiful, notwithstanding the moonlight.

The Norman Lockyer Observatory, Sidmouth, England, has elected Dr. Otto Klotz, Chief Astronomer and Director of the Dominion Astronomical Observatory, Ottawa, an honorary overseas member.

Prof. Joel Stebbins has entered upon his new duties as professor of astronomy and director of the Washburn Observatory at the University of Wisconsin succeeding Professor G. C. Comstock, who has been director since 1889.

The death is announced, at the age of seventy-one years, of Jacobus Cornelius Kapteyn, professor of Astronomy and Theoretical Mechanics since 1888 at the University of Groningen, Holland. Prof. Kapteyn's name has been well known to English-speaking astronomers since 1905, when he read a paper at the meeting of the British Association in South Africa on the proper motions of stars. In this paper he showed, according to a summing up by Sir F. W. Dyson, "that the proper motions had a general tendency towards two different points of the sky and not towards one only, as would be expected if the motions of the stars themselves were haphazard, but viewed from a point in rapid motion.

He concluded from this that there was a general tendency of the stars to stream in two opposite directions. It is interesting to notice that this great discovery was made by a simple graphical examination of the proper motions of stars in different regions of the sky, after the author had spent much time in examining and criticizing the different methods which had been adopted for the determination of the direction of the solar motion."

AN EXPLANATION OF THE "GEGENSCHEIN"

P. R. Chidambara Iyer, Assistant in the Kodaikanal Solar Physics Observatory, S. India, under date of 16th May, writes as follows:

To the Editor, Journal of the Royal Astronomical Society of Canada:

Sir: In the article "Some Speculations on Relativity" by A. V. Franklin in your Journal for September-October, 1921, the writer shows that "Relativity" will lead us to conclude that the heat of the sun as at present calculated is incorrect.

On the same lines of argument, I wonder if the following results also do not follow:

(*a*) The sizes of the sun and the moon are different from what modern calculations show, and in the case of the sun any difference in size will materially alter its density.

(*b*) The position of a star, except when overhead, will not be as it appears to us.

(*c*) The illuminated portion of the earth under the sun or the moon will be greater than a hemisphere.

(*d*) Rays of the sun which are attracted by the earth's gravitational field, but which do not fall on it, will meet and cut one another in space opposite the sun, giving rise to a patch of light elliptical in shape on account of the difference in the strength of the field at the polar and equatorial regions of the earth. This is probably the "Gegenschein", which is said to be an oval patch of light with its length along the ecliptic. If it is found that the major axis of the elliptic patch is in the plane of the earth's equator, it is almost certain that the phenomenon is explained by "Relativity".

GREAT STELLAR DISTANCES.

Harlow Shapley, in the Proceedings of the National Academy of Sciences of the U.S.A., for April (No. 4, Vol. 8) says: "Through a study of the faint variable stars in the Small Magellanic Cloud it has been possible to check the photometric methods of measuring the parallaxes of globular clusters. The great distances now ascribed to the globular systems require that the cluster type variables, with periods less than one day, be of high luminosity. The high absolute brightness of typical Cepheids, with periods longer than one day, is commonly accepted; but the faintness of the galactic variables of the cluster type, and their peculiarly large radial velocities, suggest that studies of their proper motions and trigonometric parallaxes will contribute little in the near future to the problem of their average absolute magnitude. It is now found, however, that the faintest variables in the Small Magellanic Cloud are Cepheids of the cluster type, and they are but one magnitude fainter than the typical Cepheids with periods of three days. . . . We are led to the conclusion, even after making ample allowance for the provisional nature of the magnitude scale and for the uncertainties that affect some of the periods, that cluster type variables are giant stars in the Small Magellanic Cloud, as previously found for certain globular clusters. Naturally we infer that they are giant stars wherever they occur."

INTERFEROMETER OBSERVATIONS OF STAR DIAMETERS.

F. G. Pease, writing from the Mount Wilson Observatory on May 9th to the Publications of the Astronomical Society of the Pacific, for June, 1922 (Vol. XXXIV, No. 199), says: "Observations of stellar diameters made before July 14, 1921, were given in the August, 1921, number of these Publications. Additional measures have since been made on many stars, the greater part of the programme being devoted to the calibration of the interferometer beam by means of early type stars having small diameters. Dr. Michelson and the writer will publish provisional results for a dozen stars as soon as adjustments have been made for the troublesome factors of seeing and magnitude. The values for Antares and Arcturus remain as published before. Aldebaran has ahown fringes up to the end of the beam and it is estimated

their disappearance would take place in the neighbourhood of 22 feet. Betelgeuse this season has shown no fringes beyond 8¼ feet. As compared with previous observations this might suggest an increase in its apparent diameter, possibly related to the variability in brightness of the star. The quality of the seeing, however, has been poor and no decision can be reached until further measurements have been made."

NEW STARS.

Director Heber D. Curtis of the Allegheny Observatory, speaking of "Modern Theories of the Spiral Nebulae" in the Smithsonian Report for 1919 just issued, and referring to the subject of new stars in spiral nebulae, says: "Within historical times some 27 new stars have suddenly flashed out in the heavens. . . . Two of these novae had appeared in spiral nebulae, but this fact had not been weighed at its true value. Within the past two years (written in 1919) over a dozen novae have been found in spiral nebulae, all of them very faint, ranging from about the fourteenth to the nineteenth magnitudes at maximum. Their life history, so far as we can tell from such faint objects, appears to be identical with that of the brighter novae. Now, the brighter novae of the past—that is, those which have not appeared in spirals—have almost invariably been a galactic phenomenon, located in or close to our Milky Way, and they have very evidently been a part of our own stellar system. . . . If 27 novae have appeared in our own galaxy within the past 300 years, and if about half that number are found within a few years in spiral nebulae far removed from the galactic plane, the presumption that these spirals are themselves galaxies composed of hundreds of millions of stars is a very probable one."

THE CHANGING FACE OF THE SKY.

In the recent photographic work at the Harvard Station at Arequipa, Peru, Professor Solon I. Bailey, in H.C. 234, announces the results obtained by Miss Ida E. Woods on a star cluster (N.G.C. 3201) which make it one of the most interesting in the sky. A count of the stars in the cluster gave more than one variable in every nine. Dr. Harlow Shapley, Director of the Harvard College Observatory, while on a recent visit to Europe, in an address to

the British Astronomical Association on May 31, referred also to the astonishing frequency of galactic novae, Prof. Bailey having found that about 15 new stars, down to about the tenth magnitude, appear every year.

NEW MEASUREMENTS OF THE AURORA.

Prof. Karl Störmer gives a number of new measurements of the heights of auroras in No. 8, Vol. II of the Norwegian Geophysical Commission's publications recently published. The observations were made on March 22nd, 1920, at Christiana and two other places farther north, simultaneously, by photographic method. The auroral altitudes calculated for three points of light in the auroral display were 143, 177 and 214 kilometers. An auroral arc also seen from a station near Christiana was close to the horizon, but at a place 700 kilometers northwest the arc was overhead. This gives some notion of the great altitude of the arc above the surface of the earth.

DARK NEBULAE.

Henry Norris Russell, in the Proceedings of the National Academy of Sciences of the U.S.A. for May, 1922 (No. 5, Vol. 8), says: "It is now generally believed that many of the dark markings in the Milky Way, and dark starless regions in the sky, are produced by the interposition of huge obscuring clouds between us and the remoter stars. A long list of such dark markings has been given by Barnard (Astrophysical Journal, 49, 1919, 1-23), who has done more than anyone else to point out their importance and probable nature. In some cases, as in the Pleiades, Orion and Ophiuchus, these 'regions of obscuration' merge into faintly luminous nebulosity in the vicinity of certain stars, in such a way that there can be no doubt that they lie near these stars in space.

"It thus appears that the obscuring masses or dark nebulae in Ophiuchus and Scorpio are at a distance of from 100 to 150 parsecs, those in Taurus at probably about the same distance, and those in Orion some 200 parsecs from us, while the dimensions of the individual clouds are themselves measured in parsecs.

"The occurrence of these three great regions of obscuration within a distance which is so small compared with that of the

galactic clouds indicates that such objects are probably of great cosmical temperature.

"These dark nebulae usually appear to be quite opaque. In some cases the stars can be seen faintly through them, apparently without much change in colour, but in certain instances stars imbedded in dense luminous nebulosity are abnormally red.

"Of the various forms in which matter may be distributed in space, by far the most efficient in producing obscuration is fine dust, since this has the greatest superficial area per unit of mass. . . .

"Obscuration of light in space, therefore, whether general or selective with respect to wave-length, will be produced mainly by dust particles a few millionths of an inch in diameter, unless such particles form a negligible proportion by weight of the obscuring cloud. . . .

"Dwarf stars will hardly repel dust at all, but giant stars, and especially the very luminous one of Class B, will repel it very powerfully. Only the coarser particles can come near such a star—the finer ones being driven away. This selective removal, from the vicinity of bright stars, of the particles which are most efficient in cloud formation, may explain the fact that the luminous portions of these dark nebulae, though centred upon stars, do not brighten up in their immediate neighbourhood as much as might have been anticipated.

"The finest dust must continue to be repelled by the stars, whatever their distance. It may congregate to some degree in interstellar regions, where the repulsive forces from stars on opposite sides are nearly equal, but it can be in no true equilibrium there, and must ultimately escape to an indefinitely great distance.

"Some force, however, operates to hold these dark clouds together, for their outlines are often sharp. This is probably the gravitational attraction of the cloud itself. . . .

"It can easily be shown that any dust cloud which is impervious to light must also be impervious to particles such as those of which it is composed (and to free-moving electrons as well) in the sense that such a particle could not traverse the cloud without a practical certainty of collision. These collisions may account for the existence of dust within the clouds, even if it was not a primitive constituent.

"The transition from these dark nebulae to luminous nebulae in the vicinity of the stars appears to occur in two ways. The first is by simple reflection of the light of the stars—which appears to occur in the nebulosity surrounding the Pleiades, the star ρ Ophiuchi, and probably in many other cases. The second is by the excitation of gaseous emission, as in the Great Nebula of Orion, which is connected with one of the greatest known regions of obscuration and itself shows signs that obscuring masses lie in front of it. . . .

"According to unpublished investigations by Hubble, it appears probable that the absorbing clouds in Orion, not far from the nebula, weaken the light of stars behind them by at least ten magnitudes. The exciting radiations probably penetrate to a relatively small depth into the mass and, even if they went deeper, little of the excited light could get out again. The Orion nebula, on this hypothesis, may be regarded almost as a superficial fluorescence of the gaseous portion of this vast dark cloud, in the limited region where it is stimulated by the influence of the exciting stars."

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